XV. Mathematics, Grade 10

Grade 10 Mathematics Test

The spring 2015 grade 10 Mathematics test was based on standards in the 2011 *Massachusetts Curriculum Framework for Mathematics* that match content in the grade 9–10 standards from the 2000 *Massachusetts Mathematics Curriculum Framework*. The standards in the 2011 *Framework* on the grade 10 test are organized under the five major conceptual categories listed below.

❚ Number and Quantity

❚ Algebra

❚ Functions

❚ Geometry

❚ Statistics and Probability

The *Massachusetts Curriculum Framework for Mathematics* is available on the Department website at www.doe.mass.edu/frameworks/current.html. More information and a list of standards assessable on the spring 2015 test are available at www.doe.mass.edu/mcas/transition/?section=math10.

Mathematics test results for grade 10 are reported under four MCAS reporting categories, which are based on the five *Framework* conceptual categories listed above.

The table at the conclusion of this chapter indicates each item's reporting category, the 2011 *Framework* standard it assesses, and the 2000 *Framework* standard it assesses. The correct answers for multiple-choice and short-answer items are also displayed in the table.

Test Sessions

The grade 10 Mathematics test included two separate test sessions, which were administered on consecutive days. Each session included multiple-choice and open-response items. Session 1 also included short-answer items.

Reference Materials and Tools

Each student taking the grade 10 Mathematics test was provided with a grade 10 Mathematics Reference Sheet. A copy of the reference sheet follows the final question in this chapter.

During Session 2, each student had sole access to a calculator with at least four functions and a square root key. Calculator use was not allowed during Session 1.

During both Mathematics test sessions, the use of bilingual word-to-word dictionaries was allowed for current and former English language learner students only. No other reference tools or materials were allowed.

Grade 10 Mathematics
SESSION 1

You may use your reference sheet during this session.
*You may **not** use a calculator during this session.*

DIRECTIONS
This session contains fourteen multiple-choice questions, four short-answer questions, and three open-response questions. Mark your answers to these questions in the spaces provided in your Student Answer Booklet.

1 The first five terms in a geometric sequence are shown below.

$$4, \ 12, \ 36, \ 108, \ 324, \ldots$$

What is the next term in the sequence?
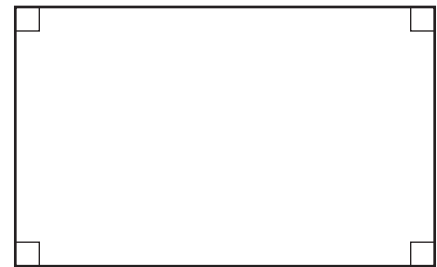
A. 432

B. 648

C. 972

D. 1296

2 Which of the following is equivalent to the expression below?

$$x^2 + 7x - 60$$

A. $(x + 12)(x - 5)$

B. $(x + 10)(x - 6)$

C. $(x + 15)(x - 4)$

D. $(x + 20)(x - 3)$

3 The length, in centimeters, of a rectangle is represented by an expression, as shown in the diagram below.

$$2 + \sqrt{45}$$

Based on the diagram, which of the following is closest to the length, in centimeters, of the rectangle?

A. 8.3

B. 8.7

C. 9.1

D. 9.5

4 Giselle surveyed 10 students at random about the number of people in their household and the number of times laundry is washed in their household each week. The results of her survey are shown in the table below.
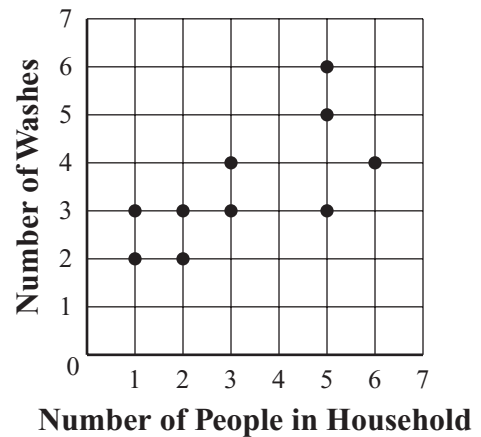
Weekly Laundry Washes

Number of People in Household	2	3	2	3	6	5	3	4	3	4
Number of Washes	1	2	2	5	5	5	1	6	3	3

Which of the following scatterplots best represents the data in the table?
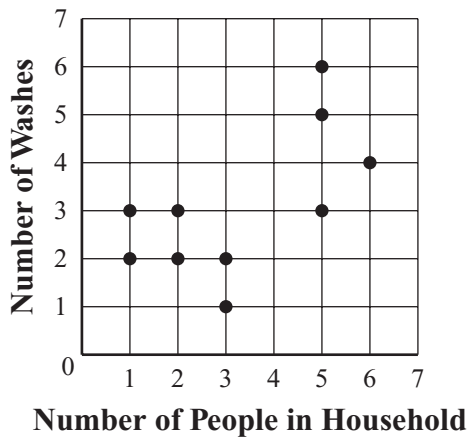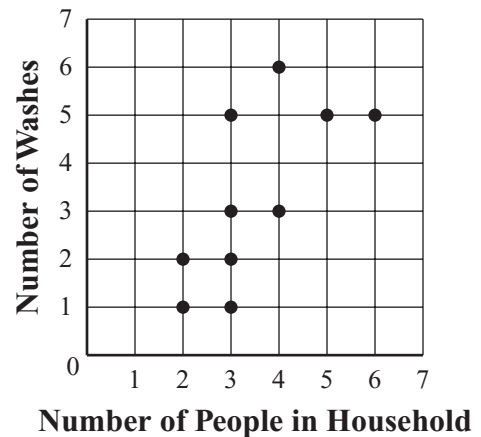
A. **Weekly Laundry Washes**
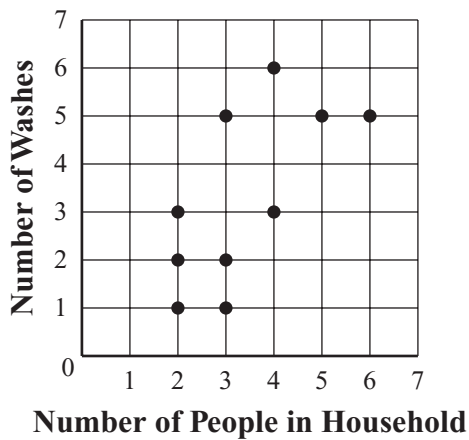
C. **Weekly Laundry Washes**

B. **Weekly Laundry Washes**

D. **Weekly Laundry Washes**

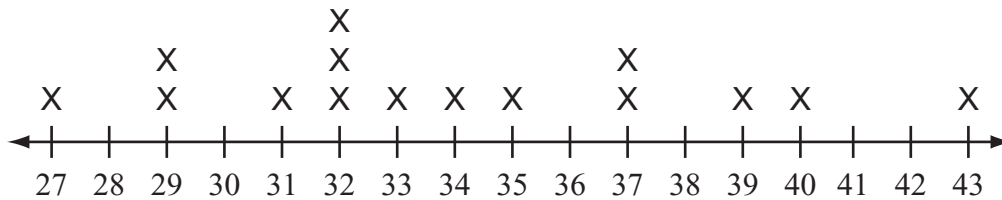**5** What is the value of the expression below?

$$(5 + 4)^2 - (5 + 4^2)$$

A. 20

B. 52

C. 60

D. 92

6 What are the solutions of the equation below?

$$(x - 2)(x + 9) = 0$$

A. $x = -2; \quad x = -9$

B. $x = -2; \quad x = 9$

C. $x = 2; \quad x = -9$

D. $x = 2; \quad x = 9$

7 The line plot below shows the fuel efficiency, in miles per gallon, for the vehicles owned by a rental car company.

Fuel Efficiency (miles per gallon)

Based on the line plot, what is the median fuel efficiency, in miles per gallon, for the vehicles?

A. 32

B. 33

C. 34

D. 35

8 Jay and Kalani graphed lines on a coordinate plane. Jay's line is represented by the equation below.

$$y = 2x - 5$$

Kalani's line is parallel to Jay's line. Which of the following could be an equation of Kalani's line?

A. $2x + y = -5$

B. $-2x + y = 5$

C. $x + 2y = -5$

D. $-x + 2y = 5$

9 The first 2,450 people to attend a baseball game received a free hat. A total of 19,544 people attended the game.

Which of the following is closest to the fraction of people attending the game who received a free hat?

A. $\frac{1}{20}$

B. $\frac{1}{8}$

C. $\frac{1}{5}$

D. $\frac{1}{4}$

10 Which of the following is equivalent to the expression below?

$$4 + 36 \div 2 \cdot 5^2 - 3$$

A. $4 + 18 \cdot 25 - 3$

B. $4 + 36 \div 20 - 3$

C. $40 \div 2 \cdot 10 - 3$

D. $40 \div 2 \cdot 25 - 3$

11 The scatterplot below shows the relationship between the total monthly sales, in millions of dollars, at a retail store and the monthly commissions, in dollars, earned by one salesperson.

Retail Store Sales

**Total Monthly Sales
(in millions of dollars)**

Based on the line of best fit for the scatterplot, which of the following is closest to the monthly commission that the salesperson could expect to make when the total monthly sales at the retail store are $0.8 million?

A. $1500

B. $2500

C. $4500

D. $6500

12 Which of the following is equivalent to the expression below?

$$12 \cdot \frac{1}{12}$$

A. 0

B. 1

C. 24

D. 144

13 Leah took a 5-day car trip. The table below shows the number of miles she drove on each day of her trip.

Leah's Car Trip

Day of Trip	1	2	3	4	5
Miles Driven	297	179	203	131	192

Of the total number of miles that Leah drove on her trip, which of the following is closest to the percentage she drove on day 1?

A. 15%

B. 20%

C. 25%

D. 30%

**14** Which of the following is equivalent to the expression below?

$$(x + 3)(x + 4)$$

A. $x^2 + 7$

B. $x^2 + 12$

C. $x^2 + 3x + 7$

D. $x^2 + 7x + 12$

Questions 15 and 16 are short-answer questions. Write your answers to these questions in the boxes provided in your Student Answer Booklet. Do not write your answers in this test booklet. You may do your figuring in the test booklet.

15 The diagram below shows a right triangle and some of its measurements.
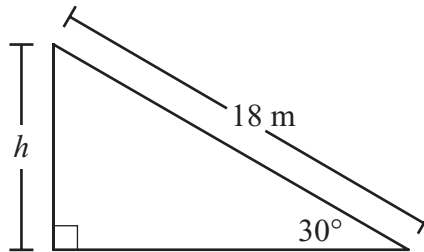
What is *h*, the height in meters of the triangle?

16 A doctor recorded the resting heart rate, in beats per minute, of each of her patients. The distribution of the heart rates for this group of patients is shown in the box-and-whisker plot below.

**Resting Heart Rate
(beats per minute)**
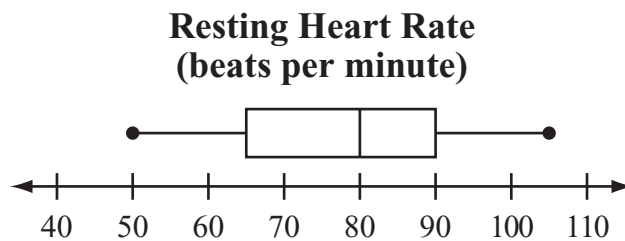
Based on the box-and-whisker plot, what was the median resting heart rate, in beats per minute, for this group of patients?

Question 17 is an open-response question.

- **BE SURE TO ANSWER AND LABEL ALL PARTS OF THE QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

Write your answer to question 17 in the space provided in your Student Answer Booklet.

17 A student is approximating the locations of square roots and cube roots of integers on a number line.

a. Between which two consecutive integers on the number line is $\sqrt{55}$ located? Show or explain how you got your answer.

b. What is the value of $\sqrt{55}$ to the nearest tenth? Show or explain how you got your answer.

The value of $\sqrt{m}$, where m is an integer, is located between 11 and 12 on the number line.

c. What could be the value of m? Show or explain how you got your answer.

The value of $\sqrt[3]{n}$, where n is an integer, is also located between 11 and 12 on the number line.

d. What could be the value of n? Show or explain how you got your answer.

Questions 18 and 19 are short-answer questions. Write your answers to these questions in the boxes provided in your Student Answer Booklet. Do not write your answers in this test booklet. You may do your figuring in the test booklet.

18 What is the value of the expression below?

$$\frac{140 - 3(-2)^4}{4}$$

**19** What is the slope of the line graphed below?
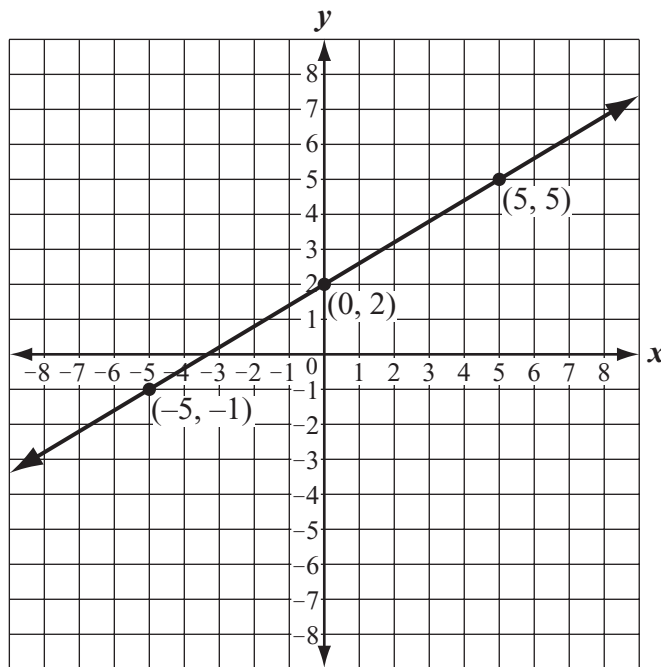
Questions 20 and 21 are open-response questions.

- **BE SURE TO ANSWER AND LABEL ALL PARTS OF EACH QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

Write your answer to question 20 in the space provided in your Student Answer Booklet.

20   A puzzle in the shape of a rectangle has six pieces. The puzzle and some of its dimensions are shown in the diagram below.
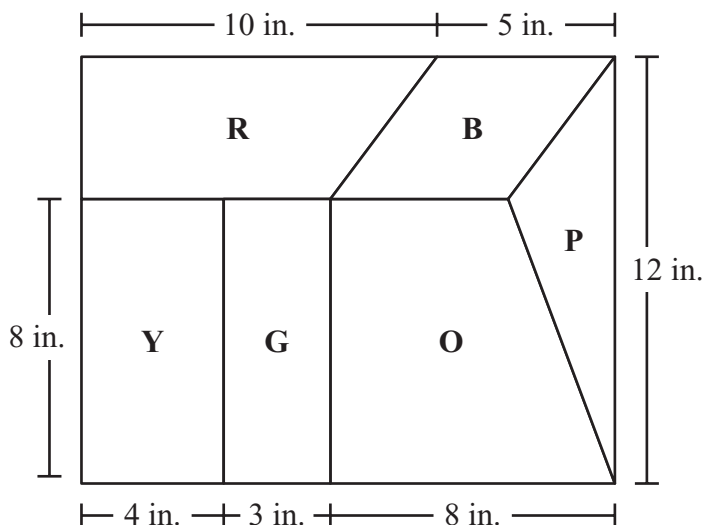

a. What is the perimeter, in inches, of the puzzle? Show or explain how you got your answer.

The shape of each piece of the puzzle is listed below.

- Pieces **R** and **O** are trapezoids.
- Pieces **Y** and **G** are rectangles.
- Piece **B** is a parallelogram.
- Piece **P** is a triangle.

b. What is the area, in square inches, of piece **B**? Show or explain how you got your answer.

c. What is the area, in square inches, of piece **R**? Show or explain how you got your answer.

d. What is the area, in square inches, of piece **P**? Show or explain how you got your answer.

Write your answer to question 21 in the space provided in your Student Answer Booklet.

21 The first five figures in a pattern are shown below.

Figure 1   Figure 2   Figure 3   Figure 4   Figure 5
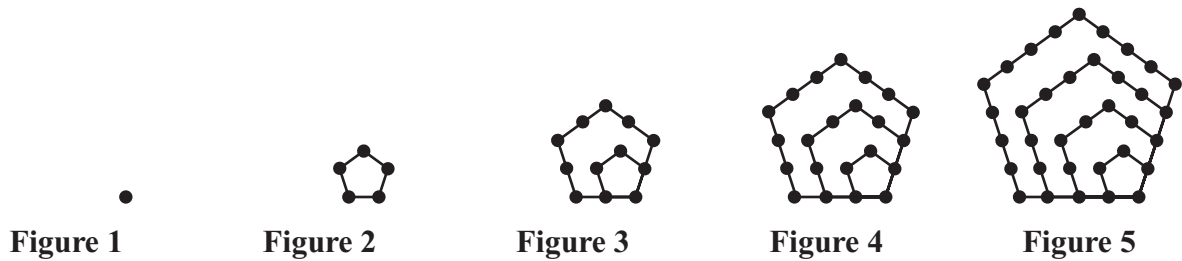
The pattern continues.

a. What is the number of pentagons in Figure 6? Show or explain how you got your answer.

b. Write an expression that represents the number of pentagons in Figure *n*.

Figure 1 is one dot. Figure 2 is composed of five dots connected by line segments.

c. What is the number of dots in **Figure 6**? Show or explain how you got your answer.

d. Explain how the number of dots in Figure 8 and the number of dots in Figure 9 can be used to determine the number of dots in Figure 10.

Grade 10 Mathematics
SESSION 2

You may use your reference sheet during this session.
You may use a calculator during this session.

DIRECTIONS

**This session contains eighteen multiple-choice questions and three open-response questions.
Mark your answers to these questions in the spaces provided in your Student Answer Booklet.**

22 Ethan poured orange juice into each of four glasses and estimated that each glass contained 8 ounces, rounded to the nearest ounce.

Based on Ethan's estimate, which of the following could be the actual total amount of orange juice in the four glasses?

A. 28.0 ounces

B. 29.6 ounces

C. 31.6 ounces

D. 34.0 ounces

23 Four equations are shown below.

$$e + f = f + e$$
$$e - f = f - e$$
$$e \cdot f = f \cdot e$$
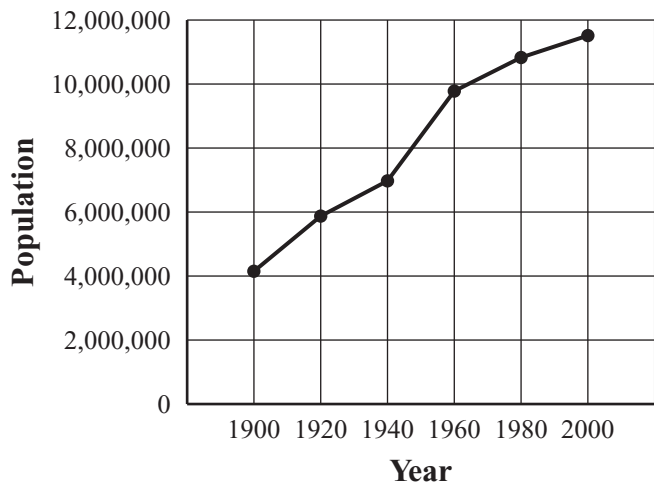$$e \div f = f \div e$$

How many of the equations are true for all real values of e and f?

A. 1

B. 2

C. 3

D. 4

24 The line graph below shows the change in the population of the state of Ohio, in twenty-year intervals, from 1900 to 2000.
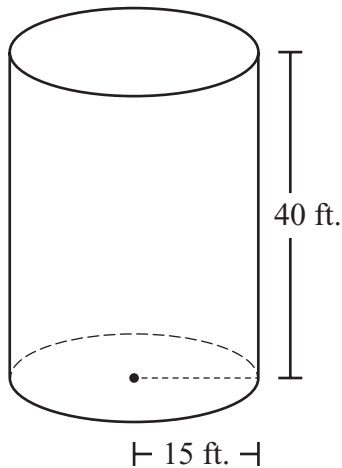
**Population of Ohio
1900–2000**

During which interval on the graph did the population of Ohio increase at the fastest rate?

A. 1900 to 1920

B. 1920 to 1940

C. 1940 to 1960

D. 1980 to 2000

25 A water tank in the shape of a right circular cylinder has a height of 40 feet and a radius of 15 feet, as shown in the diagram below.
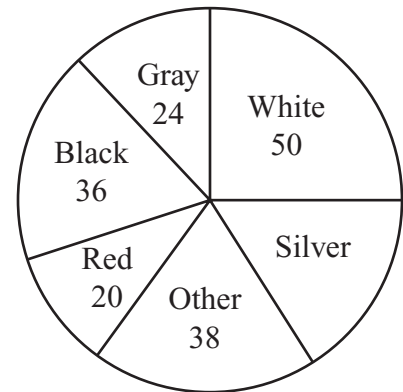

40 ft.

⊢ 15 ft. ⊣

Based on the diagram, what is the volume, in cubic feet, of the water tank?

A. 225π

B. 600π

C. 1200π

D. 9000π

26 The circle graph below represents the number of cars in a parking lot and their colors.
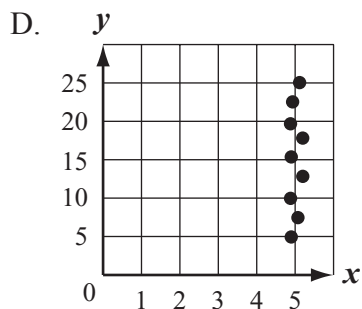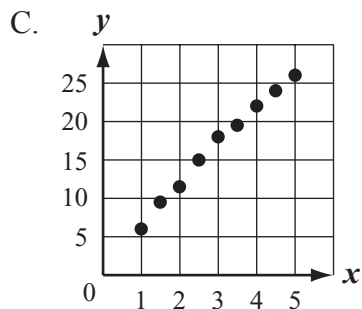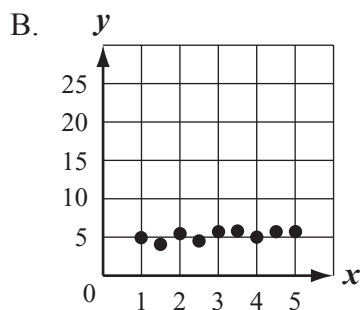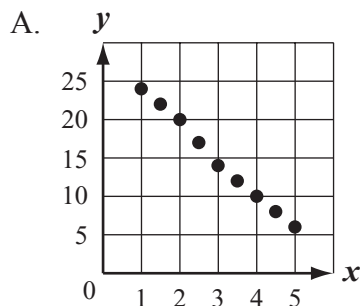
Cars in Parking Lot

If 25% of the cars in the parking lot are white, how many cars in the parking lot are silver?

A. 32

B. 36

C. 42

D. 56

27 Which of the following scatterplots is most likely to have a line of best fit with a slope of 5?

A.

B.

C.

D.

28 Two families buy refreshments at a concession stand.

- Each drink costs d dollars.
- Each snack costs s dollars.
- The Blake family buys 3 drinks and 2 snacks for $12.
- The Reese family buys 2 drinks and 4 snacks for $16.

What is the cost of one **drink** at the concession stand?

A. $2

B. $3

C. $4

D. $5

29 The first term in a sequence is 24. Each term in the sequence after the first term is equal to half the previous term, plus 4.

Which of the following statements best describes the terms in the sequence as it progresses?

A. The terms get closer to 8.

B. The terms get closer to 12.

C. The terms increase at a constant rate.

D. The terms decrease at a constant rate.

30 Brandon plans to rent a truck. The cost to rent the truck is $30 for the first four hours plus $10 for each additional hour. He can spend no more than $60.

What is the maximum number of hours for which Brandon can rent the truck?

A. 3

B. 4

C. 6

D. 7

31 A green can and a silver can are each in the shape of a right circular cylinder. The cans have the same radius, but the height of the green can is 3 times the height of the silver can.

What is the ratio of the volume of the green can to the volume of the silver can?

A. 27:1

B.   9:1

C.   6:1

D.   3:1

32 A student plotted point $G(9, 1)$ and point $H(7, -3)$ on a coordinate grid, as shown below.
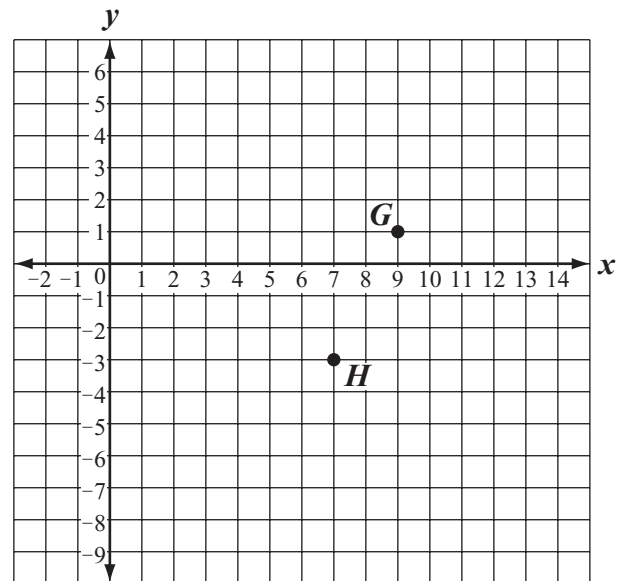
The student will plot point F so that the midpoint of $\overline{GF}$ is point H. What will be the coordinates of point F?

A. $(3, -5)$

B. $(5, -7)$

C. $(8, -1)$

D. $(11, 5)$

33 The box-and-whisker plot below shows the distribution of the times, in seconds, that members of a soccer team took to run one lap around a field.

Lap Times (in seconds)

25   30   35   40   45   50   55   60
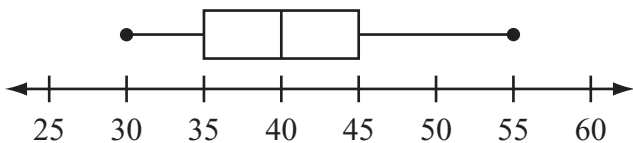
Based on the box-and-whisker plot, within which time interval did 50% of the members of the soccer team most likely run one lap around the field?

A. 30 seconds to 35 seconds

B. 35 seconds to 40 seconds

C. 35 seconds to 45 seconds

D. 45 seconds to 55 seconds

34 What is the slope of the line represented by the equation below?

$$4x + 5y = 10$$

A. $\dfrac{4}{5}$

B. $-\dfrac{4}{5}$

C. 4

D. -4

35 The diagram below shows $\triangle LMN$ and its image, $\triangle RST$, after a series of transformations in the coordinate plane.
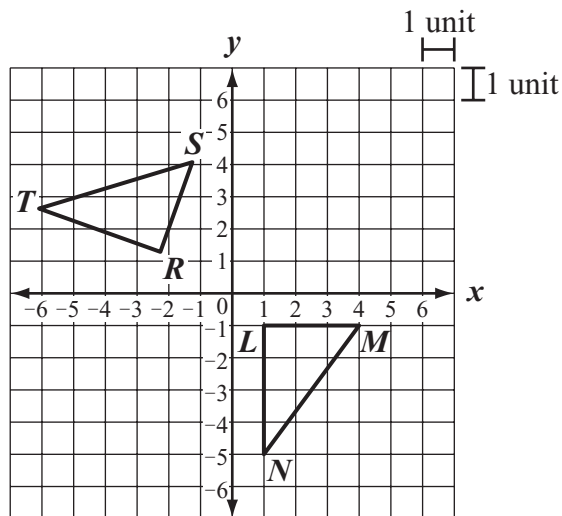
What is the length, in units, of $\overline{RT}$?

A. 3

B. 3.5

C. 4

D. 4.5

Question 36 is an open-response question.

- **BE SURE TO ANSWER AND LABEL ALL PARTS OF THE QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

Write your answer to question 36 in the space provided in your Student Answer Booklet.

36 The table below shows the numbers of students enrolled in different science classes at a high school.

**Number of Students Enrolled
in Science Classes**

Science Class	Number of Students
biology	240
environmental science	285
earth science	300
physics	195
chemistry	

There are a total of 1200 students enrolled in science classes at the high school. Each student is enrolled in only one science class.

a. What is the total number of students enrolled in chemistry class? Show or explain how you got your answer.

b. What percent of the total number of students enrolled in science classes are enrolled in chemistry class? Show or explain how you got your answer.

A guidance counselor at the high school made a circle graph based on the information in the table. The central angle of one sector of the circle graph measures 90°.

c. Which science class is represented by the sector of the circle graph that has a central angle that measures 90°? Show or explain how you got your answer.

d. What is the degree measure of the central angle of the sector of the circle graph that represents the number of students in biology class? Show or explain how you got your answer.

Mark your answers to multiple-choice questions 37 through 40 in the spaces provided in your Student Answer Booklet. Do not write your answers in this test booklet. You may do your figuring in the test booklet.

37 The diagram below shows a trapezoid and its measurements.
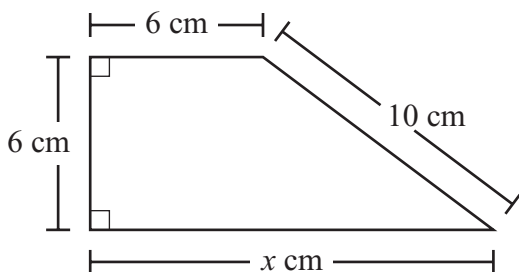
The trapezoid has an area of 60 square centimeters.

What is the value of x?

A. 10

B. 14

C. 16

D. 38

38 A right circular cone has a volume of 39 cubic inches and a radius of $2\frac{1}{2}$ inches. Which of the following is closest to the height of the cone?

A. 0.7 inch

B. 0.8 inch

C. 6 inches

D. 7 inches

39 A computer software package is sold to small-business clients. The total cost of the software package is $500 for the first 10 computers on which the software is installed, plus $20 for installation on each additional computer.

Which statement best describes the function that models the relationship between the number of computers on which the software is installed and the cost of the software?

A. It is a constant linear function for 10 or fewer computers and an exponential function for more than 10 computers.

B. It is an increasing linear function for 10 or fewer computers and an exponential function for more than 10 computers.

C. It is a constant linear function for 10 or fewer computers and an increasing linear function for more than 10 computers.

D. It is an increasing linear function for 10 or fewer computers and a constant linear function for more than 10 computers.

40 A parallelogram is graphed on the coordinate grid below.
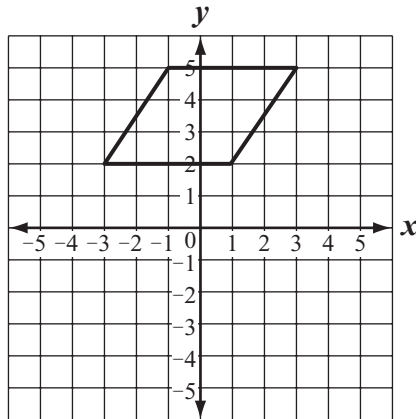
The parallelogram will be rotated 90° clockwise about the origin. Which of the following shows the location of the parallelogram after the rotation?

A.

C.

B.

D.
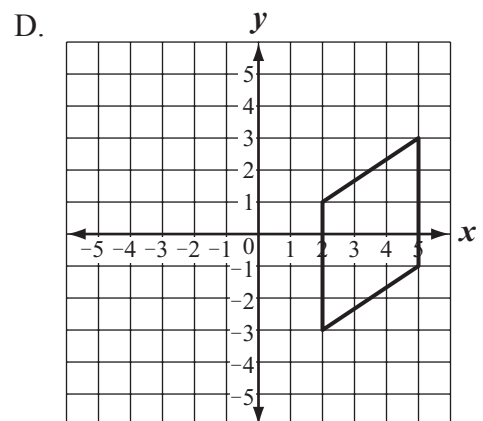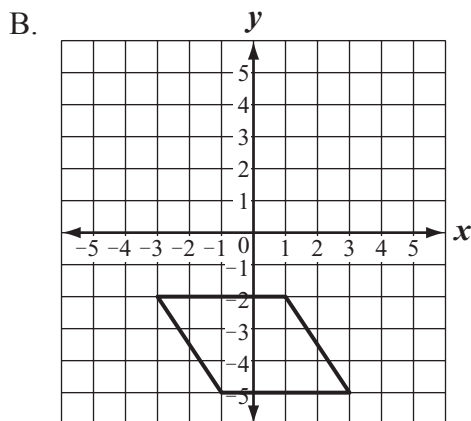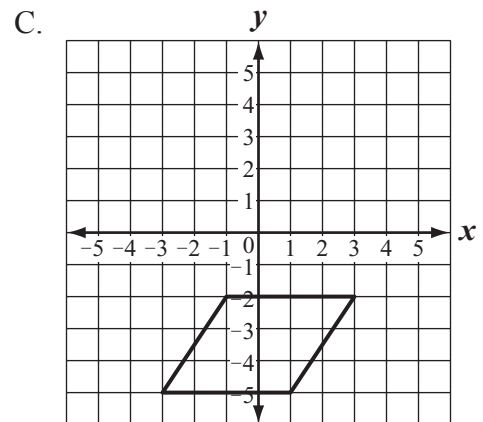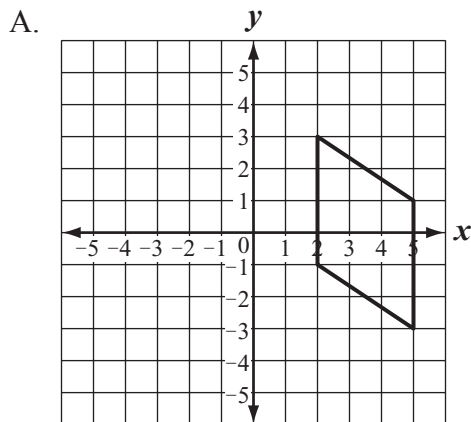
Questions 41 and 42 are open-response questions.

- **BE SURE TO ANSWER AND LABEL ALL PARTS OF EACH QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

Write your answer to question 41 in the space provided in your Student Answer Booklet.

41 The expression below can be used to calculate the balance in a savings account for which an initial deposit of P dollars has been compounded each year for t years at interest rate r.

$$P(1 + r)^t$$

Elaine opened a savings account with a deposit of $1000. The interest on her account is compounded each year at a rate of 2%. Elaine will not make any additional deposits to or withdrawals from her account.

a. What will be the balance in Elaine's account at the end of 1 year? Show or explain how you got your answer.

b. What will be the balance in Elaine's account at the end of 3 years? Show or explain how you got your answer.

Pavel opened a savings account with a deposit of $800. The interest on his account is compounded each year at a rate of 2.5%. Pavel will not make any additional deposits to or withdrawals from his account.

c. Whose account, Elaine's or Pavel's, will have earned more **interest** at the end of 3 years? Show or explain how you got your answer.

Write your answer to question 42 in the space provided in your Student Answer Booklet.

42 Parallel lines *q* and *m* are cut by transversal lines *j* and *k*. The lines, and the measures of some of the angles created by the intersections of the lines, are shown in the diagram below.
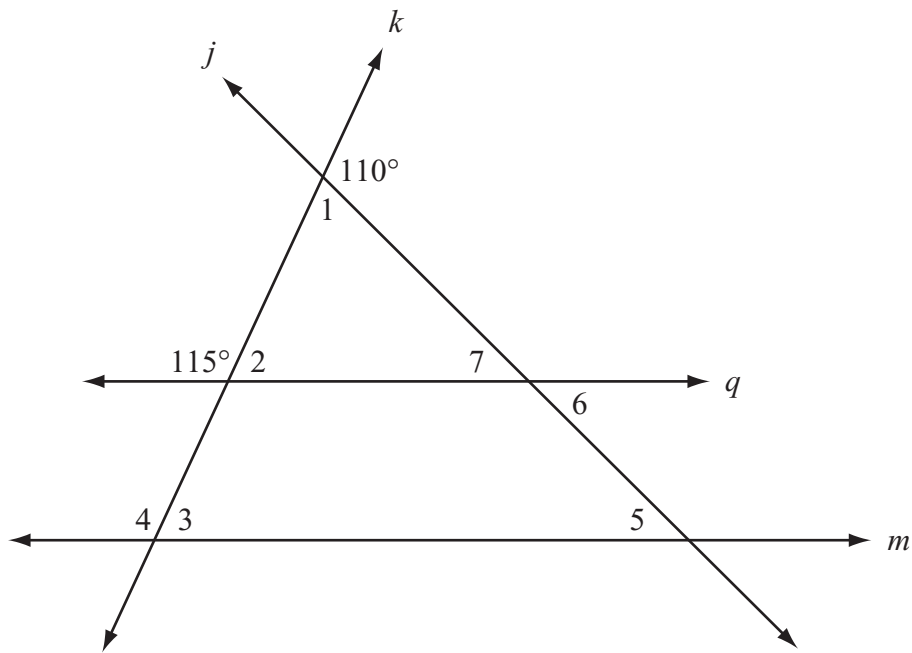
a. What is the measure, in degrees, of ∠1? Show or explain how you got your answer.

b. What is the measure, in degrees, of ∠3? Show or explain how you got your answer.

c. What is the measure, in degrees, of ∠5? Show or explain how you got your answer.

d. What is the measure, in degrees, of ∠6? Show or explain how you got your answer.

AREA FORMULAS

square .... $A = s^2$

rectangle .... $A = bh$

parallelogram .... $A = bh$

triangle .... $A = \frac{1}{2}bh$

trapezoid .... $A = \frac{1}{2}h(b_1 + b_2)$

circle .... $A = \pi r^2$

LATERAL SURFACE AREA FORMULAS

right rectangular prism .... $LA = 2(hw) + 2(lh)$

right circular cylinder .... $LA = 2\pi rh$

right circular cone .... $LA = \pi r \ell$
    (ℓ = slant height)

right square pyramid .... $LA = 2s\ell$
    (ℓ = slant height)

TOTAL SURFACE AREA FORMULAS

cube .... $SA = 6s^2$

right rectangular prism .... $SA = 2(lw) + 2(hw) + 2(lh)$

sphere .... $SA = 4\pi r^2$

right circular cylinder .... $SA = 2\pi r^2 + 2\pi rh$

right circular cone .... $SA = \pi r^2 + \pi r \ell$
    (ℓ = slant height)

right square pyramid .... $SA = s^2 + 2s\ell$
    (ℓ = slant height)

VOLUME FORMULAS

cube .... $V = s^3$
    (s = length of an edge)

right rectangular prism .... $V = lwh$

OR

$V = Bh$
(B = area of a base)

sphere .... $V = \frac{4}{3}\pi r^3$

right circular cylinder .... $V = \pi r^2 h$

right circular cone .... $V = \frac{1}{3}\pi r^2 h$

right square pyramid .... $V = \frac{1}{3}s^2 h$
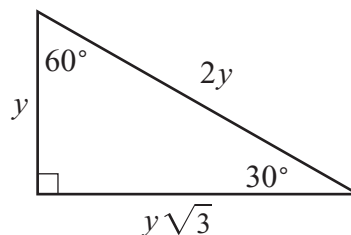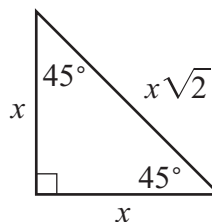
CIRCLE FORMULAS

$C = 2\pi r$

$A = \pi r^2$

SPECIAL RIGHT TRIANGLES

Grade 10 Mathematics
Spring 2015 Released Items:
Reporting Categories, Standards, and Correct Answers

Item No.	Page No.	Reporting Category[1]	Standard[1]	Correct Answer[2] (MC/SA)		2000 Standard[3]
1	242	*Algebra and Functions*	F-BF.2	C		10.P.1
2	242	*Algebra and Functions*	A-SSE.2	A		10.P.4
3	242	*Number and Quantity*	8.NS.2	B		10.N.3
4	243	*Statistics and Probability*	S-ID.6	D		10.D.1
5	244	*Number and Quantity*	7.EE.3	C		10.N.2
6	244	*Algebra and Functions*	A-REI.4	C		10.P.5
7	244	*Statistics and Probability*	S-ID.1	B		10.D.1
8	245	*Geometry*	G-GPE.5	B		10.G.8
9	245	*Number and Quantity*	7.EE.3	B		10.N.4
10	245	*Number and Quantity*	7.EE.3	A		10.N.2
11	246	*Statistics and Probability*	S-ID.6	C		10.D.2
12	246	*Number and Quantity*	7.NS.3	B		10.N.1
13	247	*Number and Quantity*	7.EE.3	D		10.N.4
14	247	*Algebra and Functions*	A-APR.1	D		10.P.3
15	248	*Geometry*	G-SRT.6	9 meters		10.G.6
16	248	*Statistics and Probability*	S-ID.1	80 beats per minute		10.D.1
17	249	*Number and Quantity*	8.NS.2			10.N.3
18	250	*Number and Quantity*	7.EE.3	23		10.N.2
19	250	*Algebra and Functions*	8.F.4	$\frac{3}{5}$		10.P.2
20	251	*Geometry*	7.G.6			10.M.1
21	252	*Algebra and Functions*	F-BF.1			10.P.1
22	253	*Number and Quantity*	N-Q.3	C		10.M.4
23	253	*Number and Quantity*	7.EE.3	B		10.N.1
24	253	*Statistics and Probability*	S-ID.7	C		10.D.1
25	254	*Geometry*	G-GMD.3	D		10.M.2
26	254	*Statistics and Probability*	6.SP.4	A		10.D.1
27	255	*Statistics and Probability*	S-ID.6	C		10.D.2
28	255	*Algebra and Functions*	A-REI.6	A		10.P.8
29	255	*Algebra and Functions*	F-BF.1	A		10.P.1
30	256	*Algebra and Functions*	A-CED.1	D		10.P.7
31	256	*Geometry*	G-GMD.3	D		10.M.3
32	256	*Geometry*	G-GPE.6	B		10.G.7
33	257	*Statistics and Probability*	S-ID.1	C		10.D.1
34	257	*Algebra and Functions*	8.F.4	B		10.P.2
35	257	*Geometry*	G-SRT.5	C		10.G.4
36	258	*Statistics and Probability*	6.SP.4			10.D.1
37	259	*Geometry*	7.G.6	B		10.M.1
38	259	*Geometry*	G-GMD.3	C		10.M.2
39	259	*Algebra and Functions*	F-LE.1	C		10.P.7
40	260	*Geometry*	G-CO.5	A		10.G.9
41	261	*Algebra and Functions*	A-CED.1			10.P.7
42	262	*Geometry*	8.G.5			10.G.3

[1] The Reporting Category and Standard columns refer to the current (2011) *Massachusetts Curriculum Framework for Mathematics*. More information about reporting categories for Mathematics is available on the Department's website at www.doe.mass.edu/mcas/tdd/math.html?section=testdesign.

[2] Answers are provided here for multiple-choice and short-answer items only. Sample responses and scoring guidelines for open-response items, which are indicated by the shaded cells, will be posted to the Department's website later this year.

[3] The Department is providing the standard from the previous (2000) curriculum framework for Mathematics for reference purposes.